Artificial Intelligence and Governments:

the Good, the Bad, and the Ugly

Martin Beraja (MIT and NBER)

NBER Digitization Tutorial, Spring 2023

AI and Governments: the Good, the Bad, and the Ugly

- AI can transform modern economies but has brought **new challenges** to the fore
- This has raised questions about **the role of governments**

AI and Governments: the Good, the Bad, and the Ugly

- AI can transform modern economies but has brought **new challenges** to the fore
- This has raised questions about **the role of governments**

1. **The Good:** AI is a data-intensive technology. New gov't policies to foster innovation?
   "*Data-intensive innovation and the state: Evidence from AI firms in China*" (with Yang and Yuchtman)

AI and Governments: the Good, the Bad, and the Ugly

- AI can transform modern economies but has brought **new challenges** to the fore
- This has raised questions about **the role of governments**

1. **The Good:** AI is a data-intensive technology. New gov't policies to foster innovation?
   "*Data-intensive innovation and the state: Evidence from AI firms in China*" (with Yang and Yuchtman)
2. **The Bad:** AI is an automation technology. How should gov'ts respond?
   "*Inefficient automation*" (with Zorzi)

AI and Governments: the Good, the Bad, and the Ugly

- AI can transform modern economies but has brought **new challenges** to the fore
- This has raised questions about **the role of governments**

1. **The Good:** AI is a data-intensive technology. New gov't policies to foster innovation?
   "*Data-intensive innovation and the state: Evidence from AI firms in China*" (with Yang and Yuchtman)
2. **The Bad:** AI is an automation technology. How should gov'ts respond?
   "*Inefficient automation*" (with Zorzi)
3. **The Ugly:** AI is a surveillance technology. Gov't misuse for repression and social control?
   "*AI-tocracy*" (with Kao, Yang and Yuchtman)
   "*Exporting the surveillance state via trade in AI*" (with Kao, Yang and Yuchtman)

The Good: access to government data as innovation policy

- Much focus on how data collected by **private** firms shapes AI innovation (Agrawal et al., 2019; Jones and Tonetti, 2020)
- Yet, throughout history, **states** have also collected massive quantities of data
- The state has a large role in many areas
  - Public security, health care, education, basic science...

The Good: access to government data as innovation policy

- Much focus on how data collected by **private** firms shapes AI innovation
  (Agrawal et al., 2019; Jones and Tonetti, 2020)
- Yet, throughout history, **states** have also collected massive quantities of data
- The state has a large role in many areas
  - Public security, health care, education, basic science...

Can access to **government data** stimulate **commercial** AI innovation?

A common way in which firms **access** to gov't data is by **providing services** to the state

A common way in which firms **access** to gov't data is by **providing services** to the state

Think about **facial recognition AI sector in China**...

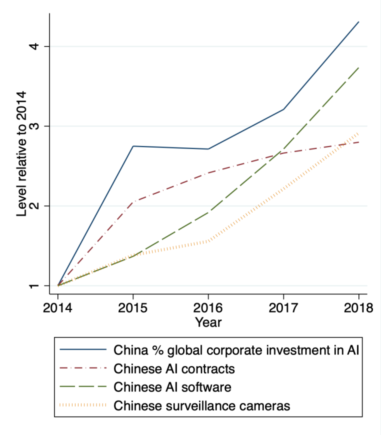
- Algo's trained on video of faces from many angles
- Government units collect this data through their surveillance apparatus, and contract AI firms

A common way in which firms **access** to gov't data is by **providing services** to the state

Think about **facial recognition AI sector in China...**

- Algo's trained on video of faces from many angles
- Government units collect this data through their surveillance apparatus, and contract AI firms

AI and the State in China

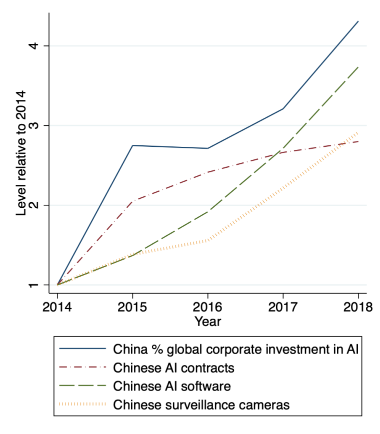


A common way in which firms **access** to gov't data is by **providing services** to the state

Think about **facial recognition AI sector in China...**

- Algo's trained on video of faces from many angles
- Government units collect this data through their surveillance apparatus, and contract AI firms
- Firms gaining access to this data use it to train algorithms and provide gov't services
- If gov't data or algorithms are **sharable** across uses, they can be used to develop commercial AI (e.g., a facial recognition platform for retail stores)

AI and the State in China



Data 1: linking AI firms to govt. contracts

1. Identify all facial recognition AI **firms**
    - 7,837 firms
    - Two sources: Tianyancha (People's Bank of China) and PitchBook (Morningstar)

Data 1: linking AI firms to govt. contracts

1. Identify all facial recognition AI **firms**
   - 7,837 firms
   - Two sources: Tianyancha (People's Bank of China) and PitchBook (Morningstar)

2. Obtain universe of **government contracts**
   - 2,997,105 contracts
   - Source: Chinese Govt. Procurement Database (Ministry of Finance)

Data 1: linking AI firms to govt. contracts

1. Identify all facial recognition AI **firms**
   - 7,837 firms
   - Two sources: Tianyancha (People's Bank of China) and PitchBook (Morningstar)

2. Obtain universe of **government contracts**
   - 2,997,105 contracts
   - Source: Chinese Govt. Procurement Database (Ministry of Finance)

3. Link government **buyers** to AI **suppliers**
   - 10,677 AI contracts issued by public security arms of government (e.g., local police department)


财政部唯一指定政府采购信息网络发布媒体 国家级政府采购专业网站 服务热线：400-810-1996

政策法规 标讯频道 中央采购 地方采购 案例解读 购买服务 PPP频道 GPA专栏 采购百科 热点专题

中国政府采购网 首页 » 地方标讯 » 中标公告

道路交通安全综合管理平台维护升级项目中标（成交）公告

2016年12月30日 16:26 来源：中国政府采购网 【打印】【显示公告概要】

1、项目名称:道路交通安全综合管理平台维护升级项目
2、项目编号: GZGC-2016-38
3、项目序列号: S5200000000007081001
4、项目联系人: 王维娟
5、项目联系人电话: 0851-85226523
6、项目用途、简要技术要求及合同履行日期: 嵌入式“人脸识别”系统软件开发
7、采购方式: 公开招标
8、采购日期 2016-12-07
9、公告媒体 贵州省政府采购网
10、评审时间: 2016-12-29
11、评审地点: 贵州省公共资源交易中心
12、评审委员会成员名单:
熊验翔、李旭、彭歆北、戚玉峰、黄荣伟
13、定标日期 2016-12-29
14、中标（成交）信息:

序号	中标供应商	中标供应商地址	主要中标内容	中标金额(元)
1	上海依图网络科技有限公司	上海市闵行区吴中路1189号，德必易园830-846室	嵌入式“人脸识别”系统软件开发	639000.00

15、PPP项目:否
16、采购人名称: 贵州省公安厅交通管理局
联系地址:贵阳市龙洞堡园林路116号
项目联系人:宋先生
联系电话:0851-85226880
17、采购代理机构全称:贵州贵财招标有限责任公司
联系地址:贵州省贵阳市观山湖区金阳北路233号贵州产业投资（集团）有限责任公司大楼413室
项目联系人:王维娟
联系电话:0851-85226523
18、采购文件上传（PDF格式）:
附件:
gzgc-2016-38(12月2日修改版).pdf
19、书面推荐供应商参加采购活动的采购人和评审专家推荐意见（如有）:
无

贵州贵财招标有限责任公司

Data 2: AI firms' software production

Registered with Min. of Industry and Information Technology

Categorize by intended customers (with RNN model using tensorflow):

1. **Commercial:** e.g., *visual recognition system for smart retail*;
2. **Government:** e.g., *smart city — real time monitoring system on main traffic routes*;
3. General: e.g., *a synchronization method for multi-view cameras based on FPGA chips.*

Data 3: measuring access to government data

Within AI public security contracts: variation in the data collection capacity of the public security agency's local surveillance network

1. Identify non-AI contracts: police department purchases of street cameras
2. Measure quantity of advanced cameras in a prefecture at a given time
3. Categorize public security contracts as coming from "high" or "low" camera capacity prefectures

Regional variation in contracts

Empirical strategy

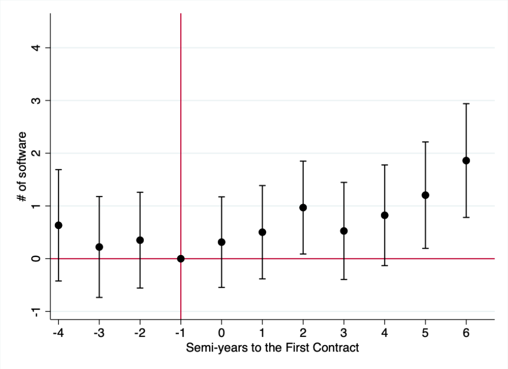
- **Triple diff:** software releases before and after firm receives 1st data-rich contract (relative to data-scarce)

$$y_{it} = \sum_T \beta_{1T} T_{it} Data_i + \sum_T \beta_{2T} T_{it} + \alpha_t + \gamma_i + \sum_T \beta_{3T} T_{it} X_i + \epsilon_{it}$$

  - T_{it}: 1 if T semi-years before/since firm i's 1st contract
  - $Data_i$: 1 if firm i receives "data rich" contract
  - X_i pre-contract controls: age, size, and software prod

Regional variation in contracts

Cumulative commercial software releases



Magnitude: 2 new products over 3 years

The Bad: Inefficient Automation

- Automation raises productivity but **displaces workers** and **lowers their earnings**

The Bad: Inefficient Automation

- Automation raises productivity but **displaces workers** and **lowers their earnings**
- Increasing adoption has fueled an active **policy** debate (Atkison, 2019; Acemoglu et al, 2020)

The Bad: Inefficient Automation

- Automation raises productivity but **displaces workers** and **lowers their earnings**
- Increasing adoption has fueled an active **policy** debate (Atkison, 2019; Acemoglu et al, 2020)
- No **optimal policy** results that take into account **frictions** faced by displaced workers

The Bad: Inefficient Automation

- Automation raises productivity but **displaces workers** and **lowers their earnings**
- Increasing adoption has fueled an active **policy** debate (Atkison, 2019; Acemoglu et al, 2020)
- No **optimal policy** results that take into account **frictions** faced by displaced workers
- Two literatures can justify taxing automation

Tax automation

Guerreiro et al 2017; Costinot-Werning 2018

(i) Govt. has preference for redistribution

(ii) Automation/reallocation are efficient

The Bad: Inefficient Automation

- Automation raises productivity but **displaces workers** and **lowers their earnings**
- Increasing adoption has fueled an active **policy** debate (Atkison, 2019; Acemoglu et al, 2020)
- No **optimal policy** results that take into account **frictions** faced by displaced workers
- Two **literatures** can justify taxing automation

Tax automation

Guerreiro et al 2017; Costinot-Werning 2018

(i) Govt. has preference for redistribution

(ii) Automation/reallocation are efficient

Tax capital (long-run)

Aiyagari 1995; Conesa et al. 2002

(i) Improve efficiency in economies with IM

(ii) Worker displacement/reallocation absent

The Bad: Inefficient Automation

- Automation raises productivity but **displaces workers** and **lowers their earnings**
- Increasing adoption has fueled an active **policy** debate (Atkison, 2019; Acemoglu et al, 2020)
- No **optimal policy** results that take into account **frictions** faced by displaced workers
- Two **literatures** can justify taxing automation. Reallocation is frictionless or absent

Tax automation

Guerreiro et al 2017; Costinot-Werning 2018

Tax capital (long-run)

Aiyagari 1995; Conesa et al. 2002

The Bad: Inefficient Automation

- Automation raises productivity but **displaces workers** and **lowers their earnings**
- Increasing adoption has fueled an active **policy** debate (Atkison, 2019; Acemoglu et al, 2020)
- No **optimal policy** results that take into account **frictions** faced by displaced workers
- Two **literatures** can justify taxing automation. Reallocation is frictionless or absent
- Recognize that displaced workers face two important **frictions**:
  - (i) **Slow reallocation**: workers face mobility barriers and may go through unempl./retraining
  - (ii) **Imperfect credit markets**: workers have limited ability to borrow against future incomes

The Bad: Inefficient Automation

- Automation raises productivity but **displaces workers** and **lowers their earnings**
- Increasing adoption has fueled an active **policy** debate (Atkison, 2019; Acemoglu et al, 2020)
- No **optimal policy** results that take into account **frictions** faced by displaced workers
- Two **literatures** can justify taxing automation. Reallocation is frictionless or absent
- Recognize that displaced workers face two important **frictions**:
  - (i) **Slow reallocation**: workers face mobility barriers and may go through unempl./retraining
  - (ii) **Imperfect credit markets**: workers have limited ability to borrow against future incomes

Could firms automate excessively? How should the gov't respond?

Outline

Laissez-faire

Optimal Policy

Quantitative Analysis

Firms

Continuous time $t \geq 0$

Firms

Continuous time $t \geq 0$

Occupations

Continuous time $t \geq 0$

Occupations

$h = A$ (degree $\alpha \geq 0$) or $h = N$

Continuous time $t \geq 0$

Occupations

$h = A$ (degree $\alpha \geq 0$) or $h = N$

$$y^A = F\left(\mu^A, \alpha\right) \quad , \quad y^N = F^{\star}\left(\mu^N\right) \equiv F\left(\mu^N, 0\right)$$

Continuous time $t \geq 0$

Occupations

$h = A$ (degree $\alpha \geq 0$) or $h = N$

$$y^A = F\left(\mu^A, \alpha\right) \quad , \quad y^N = F^\star\left(\mu^N\right) \equiv F\left(\mu^N, 0\right)$$

Final good producer

$$G^\star\left(\mu^A, \mu^N; \alpha\right) \equiv G\left(\left\{y^h\right\}\right) - \mathcal{C}\left(\alpha\right)$$

Continuous time $t \geq 0$

Occupations

$h = A$ (degree $\alpha \geq 0$) or $h = N$

$$y^A = F\left(\mu^A, \alpha\right) \quad , \quad y^N = F^\star\left(\mu^N\right) \equiv F\left(\mu^N, 0\right)$$

Final good producer

$$G^\star\left(\mu^A, \mu^N; \alpha\right) \equiv G\left(\left\{y^h\right\}\right) - \mathcal{C}\left(\alpha\right)$$

Automation

$\partial_A G^\star\left(\mu^A, \mu^N; \alpha\right) \downarrow$ in α (labor-displacing)

$G^\star\left(\mu^A, \mu^N; \alpha\right)$ concave in α (costly)

Continuous time $t \geq 0$

Occupations

$h = A$ (degree $\alpha \geq 0$) or $h = N$

$$y^A = F\left(\mu^A, \alpha\right) \quad , \quad y^N = F^\star\left(\mu^N\right) \equiv F\left(\mu^N, 0\right)$$

Final good producer

$$G^\star\left(\mu^A, \mu^N; \alpha\right) \equiv G\left(\left\{y^h\right\}\right) - \mathcal{C}\left(\alpha\right)$$

Automation

$\partial_A G^\star\left(\mu^A, \mu^N; \alpha\right) \downarrow$ in α (labor-displacing)

$G^\star\left(\mu^A, \mu^N; \alpha\right)$ concave in α (costly)

Profit maximization

$$\max_{\alpha \geq 0} \int_0^{+\infty} Q_t \Pi_t\left(\alpha\right) dt$$

Continuous time $t \geq 0$

Occupations

$h = A$ (degree $\alpha \geq 0$) or $h = N$

$$y^A = F\left(\mu^A, \alpha\right) \quad , \quad y^N = F^\star\left(\mu^N\right) \equiv F\left(\mu^N, 0\right)$$

Final good producer

$$G^\star\left(\mu^A, \mu^N; \alpha\right) \equiv G\left(\left\{y^h\right\}\right) - \mathcal{C}\left(\alpha\right)$$

Automation

$\partial_A G^\star\left(\mu^A, \mu^N; \alpha\right) \downarrow$ in α (labor-displacing)

$G^\star\left(\mu^A, \mu^N; \alpha\right)$ concave in α (costly)

Profit maximization

$$\max_{\alpha \geq 0} \int_0^{+\infty} Q_t \Pi_t\left(\alpha\right) dt$$

$$\Pi_t\left(\alpha\right) \equiv \max_{\mu^A, \mu^N \geq 0} G^\star\left(\mu^A, \mu^N; \alpha\right) - \mu^A w_t^A - \mu^N w_t^N$$

Workers

Preferences

$$U_0 = \int \exp(-\rho t) \frac{c_t^{1-\sigma}}{1-\sigma} dt$$

Preferences

$$U_0 = \int \exp(-\rho t) \frac{c_t^{1-\sigma}}{1-\sigma} dt$$

Initial allocation

$$(\mu_t^A, \mu_t^N) \begin{cases} = 1/2 & \text{in } t = 0 \\ \text{Reallocation} & \text{afterwards} \end{cases}$$

Workers

Preferences

$$U_0 = \int \exp(-\rho t) \frac{c_t^{1-\sigma}}{1-\sigma} dt$$

Initial allocation

$$(\mu_t^A, \mu_t^N) \begin{cases} = 1/2 & \text{in } t = 0 \\ \text{Reallocation} & \text{afterwards} \end{cases}$$

Budget constraint

$$da_t^h = \left[\mathcal{Y}_t^{h,\star} + r_t a_t^h - c_t^h\right] dt$$

Preferences

$$U_0 = \int \exp(-\rho t) \frac{c_t^{1-\sigma}}{1-\sigma} dt$$

Budget constraint

$$da_t^h = \left[\mathcal{Y}_t^{h,\star} + r_t a_t^h - c_t^h\right] dt$$

Initial allocation

$$(\mu_t^A, \mu_t^N) \begin{cases} = 1/2 & \text{in } t = 0 \\ \text{Reallocation} & \text{afterwards} \end{cases}$$

Two frictions

1. Reallocation (neoclassical)

Preferences

$$U_0 = \int \exp(-\rho t) \frac{c_t^{1-\sigma}}{1-\sigma} dt$$

Budget constraint

$$da_t^h = \left[\mathcal{Y}_t^{h,\star} + r_t a_t^h - c_t^h \right] dt$$

Initial allocation

$$(\mu_t^A, \mu_t^N) \begin{cases} = 1/2 & \text{in } t = 0 \\ \text{Reallocation} & \text{afterwards} \end{cases}$$

Two frictions

1. Reallocation (neoclassical)
   - Random opportunities arrive at rate λ

Preferences

$$U_0 = \int \exp\left(-\rho t\right) \frac{c_t^{1-\sigma}}{1-\sigma} dt$$

Budget constraint

$$da_t^h = \left[\mathcal{Y}_t^{h,\star} + r_t a_t^h - c_t^h\right] dt$$

Initial allocation

$$\left(\mu_t^A, \mu_t^N\right) \begin{cases} = 1/2 & \text{in } t = 0 \\ \text{Reallocation} & \text{afterwards} \end{cases}$$

Two frictions

1. Reallocation (neoclassical)
   - Random opportunities arrive at rate λ
   - Unempl. / retrain. exit at rate κ

Preferences

$$U_0 = \int \exp(-\rho t) \frac{c_t^{1-\sigma}}{1-\sigma} dt$$

Budget constraint

$$da_t^h = \left[\mathcal{Y}_t^{h,\star} + r_t a_t^h - c_t^h \right] dt$$

Initial allocation

$$(\mu_t^A, \mu_t^N) \begin{cases} = 1/2 & \text{in } t = 0 \\ \text{Reallocation} & \text{afterwards} \end{cases}$$

Two frictions

1. Reallocation (neoclassical)
   - Random opportunities arrive at rate λ
   - Unempl. / retrain. exit at rate κ
   - Productivity loss θ

Workers

Preferences

$$U_0 = \int \exp(-\rho t) \frac{c_t^{1-\sigma}}{1-\sigma} dt$$

Initial allocation

$$(\mu_t^A, \mu_t^N) \begin{cases} = 1/2 & \text{in } t = 0 \\ \text{Reallocation} & \text{afterwards} \end{cases}$$

Budget constraint

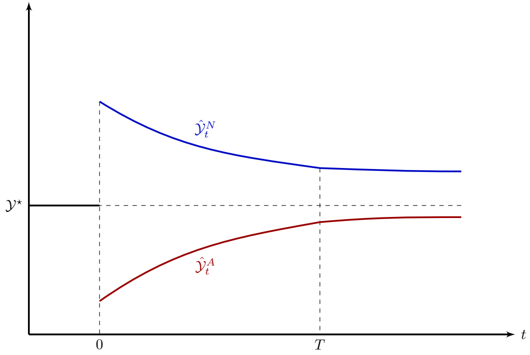
$$da_t^h = \left[\mathcal{y}_t^{h,\star} + r_t a_t^h - c_t^h\right] dt$$

Two frictions

1. Reallocation (neoclassical)
   - Random opportunities arrive at rate λ
   - Unempl. / retrain. exit at rate κ
   - Productivity loss θ
2. Borrowing

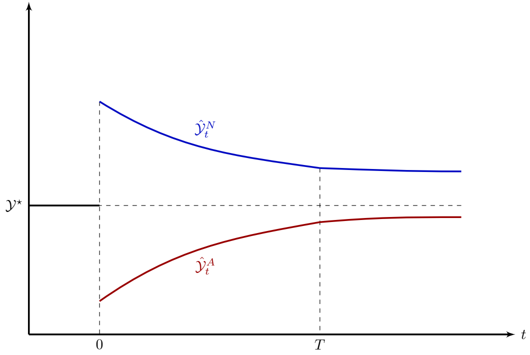
$$a_t^h \geq \underline{a} \quad \text{for some} \quad \underline{a} \leq 0$$

Average income



Binding Borrowing Constraints

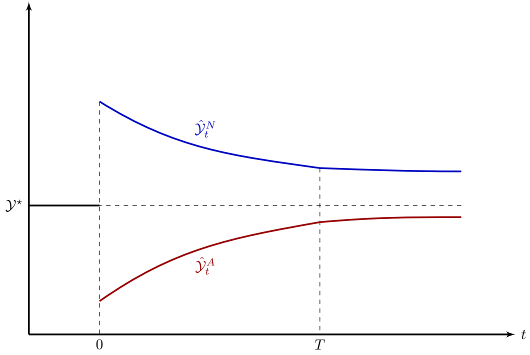
Average income



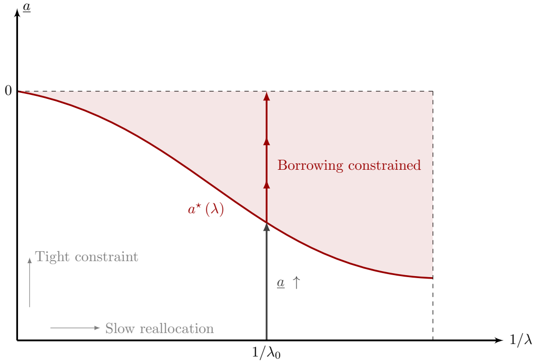
Workers expect income to improve as they reallocate → Motive for **borrowing**

Binding Borrowing Constraints

Average income

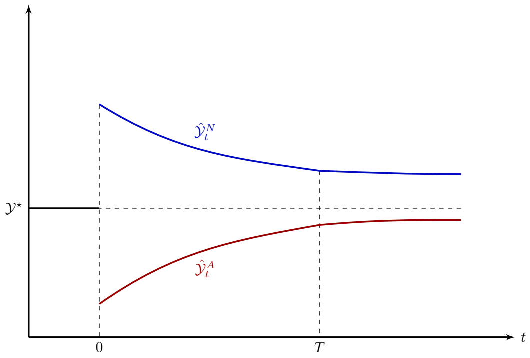


Binding borrowing constraints

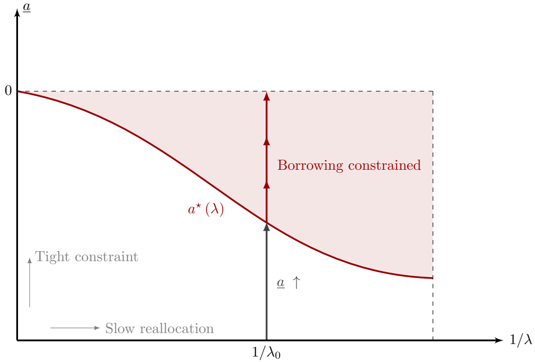


Workers expect income to improve as they reallocate → Motive for **borrowing**

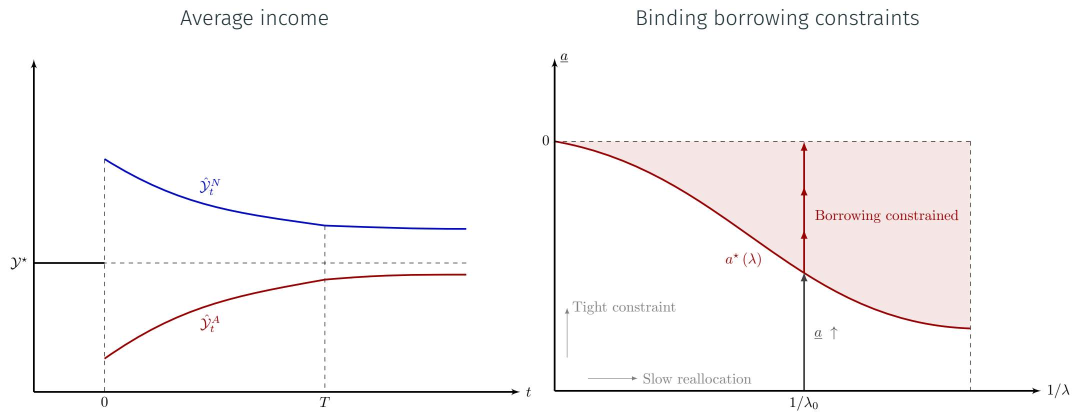
Average income



Binding borrowing constraints



Two benchmarks: instant realloc. (Costinot-Werning) or no borrowing frictions (Guerreiro et al)



Evidence: Earnings partially recover (Jacobson et al) + Imperfect cons. smoothing (Landais-Spinnewijn)

Laissez-faire: Automation

- Firm automation choice α^{LF}: trades off cost $\mathcal{C}(\alpha)$ with increase in output

Laissez-faire: Automation

- Firm automation choice α^{LF}: trades off cost $\mathcal{C}(\alpha)$ with increase in output
- Optimality condition

$$\int_0^{+\infty} Q_t \Delta_t^{\star} dt = 0$$

where

$$\Delta_t^{\star} \equiv \frac{\partial}{\partial \alpha} G^{\star}\left(\mu_t^A, \mu_t^N; \alpha^{\text{LF}}\right)$$

denotes the output gains (net of cost) from automation, and

$$Q_t = \exp\left(-\int_0^t r_s ds\right) = \exp\left(-\rho t\right) \frac{u'\left(c_t^N\right)}{u'\left(c_0^N\right)}$$

since non-automated workers are unconstrained (savers).

Outline

Laissez-faire

Optimal Policy

Quantitative Analysis

Constrained Ramsey problem

How should a government respond to automation?

Constrained Ramsey problem

How should a government respond to automation?

- Depends on the **tools** available

Constrained Ramsey problem

How should a government respond to automation?

- Depends on the **tools** available
- **First best tools**: **lump sum transfers** (directed, UBI)

  Info requirements? Fiscal cost? (Guerreiro et al., 2017; Costinot-Werning, 2018, Guner et al., 2021)

Constrained Ramsey problem

How should a government respond to automation?

- Depends on the **tools** available
- **Second best tools**: tax automation + active labor market interventions

  E.g., South Korea's reduction in automation tax credit in manuf; Geneva's tax on automated cashiers.

How should a government respond to automation?

- Depends on the **tools** available
- **Second best tools**: **tax automation + active labor market interventions**

  E.g., South Korea's reduction in automation tax credit in manuf; Geneva's tax on automated cashiers.
- **Primal problem:** The government maximizes the social welfare function

$$\mathcal{U} \equiv \sum_h \eta^h \int_0^{+\infty} \exp(-\rho t)\, u\left(c_t^h\right) dt$$

by choosing $\{\alpha, T, \mu_t^A, \mu_t^N, c_t^A, c_t^N\}$ subject to workers choosing consumption optimally, the law of motion of labor, firms choosing labor optimally, and market clearing.

- Consider a perturbation $\delta\alpha$ starting from the laissez-faire. Welfare change

$$\frac{\delta \mathcal{U}}{\delta \alpha} = \eta^N u'\left(c_0^N\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right) \frac{u'\left(c_t^N\right)}{u'\left(c_0^N\right)}}_{=\exp\left(-\int_0^t r_s ds\right)} \times \left(\Delta_t^\star + \Sigma_t^{N,\star}\right) dt$$

$$+ \eta^A u'\left(c_0^A\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right) \frac{u'\left(c_t^A\right)}{u'\left(c_0^A\right)}}_{\text{How automated workers value flows}} \times \left(\Delta_t^\star + \Sigma_t^{A,\star}\right) dt$$

where $\Delta_t^\star$ is aggregate term and $\Sigma_t^{A,\star} + \Sigma_t^{N,\star} = 0$ are distributional terms.

Aggregate vs. Distributional Effects

- Consider a perturbation $\delta\alpha$ starting from the laissez-faire. Welfare change

$$\frac{\delta\mathcal{U}}{\delta\alpha} = \eta^N u'\left(c_0^N\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right)\frac{u'\left(c_t^N\right)}{u'\left(c_0^N\right)}}_{=\exp\left(-\int_0^t r_s ds\right)} \times \left(\cancel{\Delta_t^\star} + \Sigma_t^{N,\star}\right) dt$$

$$+\, \eta^A u'\left(c_0^A\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right)\frac{u'\left(c_t^A\right)}{u'\left(c_0^A\right)}}_{\text{How automated workers value flows}} \times \left(\cancel{\Delta_t^\star} + \Sigma_t^{A,\star}\right) dt$$

where $\Delta_t^\star$ is aggregate term and $\Sigma_t^{A,\star} + \Sigma_t^{N,\star} = 0$ are distributional terms.

- No borrowing constraints $\rightarrow \frac{u'(c_t^N)}{u'(c_0^N)} = \frac{u'(c_t^A)}{u'(c_0^A)} \rightarrow$ **Efficiency** (only distributional terms)

- Consider a perturbation $\delta\alpha$ starting from the laissez-faire. Welfare change

$$\frac{\delta \mathcal{U}}{\delta \alpha} = \eta^N u'\left(c_0^N\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right) \frac{u'\left(c_t^N\right)}{u'\left(c_0^N\right)}}_{=\exp\left(-\int_0^t r_s ds\right)} \times \left(\Delta_t^\star + \Sigma_t^{N,\star}\right) dt$$

$$+ \eta^A u'\left(c_0^A\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right) \frac{u'\left(c_t^A\right)}{u'\left(c_0^A\right)}}_{\text{How automated workers value flows}} \times \left(\Delta_t^\star + \Sigma_t^{A,\star}\right) dt$$

where $\Delta_t^\star$ is aggregate term and $\Sigma_t^{A,\star} + \Sigma_t^{N,\star} = 0$ are distributional terms.

- No borrowing constraints $\rightarrow \frac{u'(c_t^N)}{u'(c_0^N)} = \frac{u'(c_t^A)}{u'(c_0^A)} \rightarrow$ **Efficiency** (only distributional terms)
- Still rationale for redistribution since $u'\left(c_t^N\right) < u'\left(c_t^A\right)$, e.g., utilitarian weights

- Consider a perturbation $\delta\alpha$ starting from the laissez-faire. Welfare change

$$\frac{\delta \mathcal{U}}{\delta \alpha} = \eta^N u'\left(c_0^N\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right) \frac{u'\left(c_t^N\right)}{u'\left(c_0^N\right)}}_{=\exp\left(-\int_0^t r_s ds\right)} \times \left(\Delta_t^\star + \Sigma_t^{N,\star}\right) dt$$

$$+ \eta^A u'\left(c_0^A\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right) \frac{u'\left(c_t^A\right)}{u'\left(c_0^A\right)}}_{\text{How automated workers value flows}} \times \left(\Delta_t^\star + \Sigma_t^{A,\star}\right) dt$$

where $\Delta_t^\star$ is aggregate term and $\Sigma_t^{A,\star} + \Sigma_t^{N,\star} = 0$ are distributional terms.

- Borrowing constraints $\rightarrow \frac{u'(c_t^N)}{u'(c_0^N)} > \frac{u'(c_t^A)}{u'(c_0^A)} \rightarrow$ **Inefficiency**

- Consider a perturbation $\delta\alpha$ starting from the laissez-faire. Welfare change

$$\frac{\delta \mathcal{U}}{\delta\alpha} = \eta^N u'\left(c_0^N\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right)\frac{u'\left(c_t^N\right)}{u'\left(c_0^N\right)}}_{=\exp\left(-\int_0^t r_s ds\right)} \times \left(\Delta_t^\star + \Sigma_t^{N,\star}\right) dt$$

$$+\, \eta^A u'\left(c_0^A\right) \times \int_0^{+\infty} \underbrace{\exp\left(-\rho t\right)\frac{u'\left(c_t^A\right)}{u'\left(c_0^A\right)}}_{\text{How automated workers value flows}} \times \left(\Delta_t^\star + \Sigma_t^{A,\star}\right) dt$$

where $\Delta_t^\star$ is aggregate term and $\Sigma_t^{A,\star} + \Sigma_t^{N,\star} = 0$ are distributional terms.

- Borrowing constraints $\rightarrow \frac{u'(c_t^N)}{u'(c_0^N)} > \frac{u'(c_t^A)}{u'(c_0^A)} \rightarrow$ **Inefficiency**

There is a **conflict** between how the firm and displaced workers value the **effects of automation over time**. This creates room for **Pareto improvements**.

Constrained Inefficiency (for any Pareto weights)

Proposition. (Constrained inefficiency)

Generically, there exists $\{\delta\alpha, \delta T\}$ such that $\delta U^A > 0$ and $\delta U^N = 0$. This requires $\delta\alpha < 0$.

Constrained Inefficiency (for <u>any</u> Pareto weights)

Proposition. (Constrained inefficiency)

Generically, there exists $\{\delta\alpha, \delta T\}$ such that $\delta U^A > 0$ and $\delta U^N = 0$. This requires $\delta\alpha < 0$.

(automated)

$$\delta\alpha \times \int_0^{+\infty} \exp\left(-\rho t\right) \frac{u'(c_t^A)}{u'(c_0^A)} \left(\Delta_t^\star + \Sigma_t^{\star,A}\right) dt$$

(non-automated / firm)

$$\delta\alpha \times \int_0^{+\infty} \exp\left(-\rho t\right) \frac{u'(c_t^N)}{u'(c_0^N)} \left(\Delta_t^\star + \Sigma_t^{\star,N}\right) dt$$

Constrained Inefficiency (for any Pareto weights)

Proposition. (Constrained inefficiency)

Generically, there exists $\{\delta\alpha, \delta T\}$ such that $\delta U^A > 0$ and $\delta U^N = 0$. This requires $\delta\alpha < 0$.

(automated)

$$\delta\alpha \times \int_0^{+\infty} \exp(-\rho t) \frac{u'(c_t^A)}{u'(c_0^A)} \Delta_t^\star dt \overset{?}{=} 0$$

(non-automated / firm)

$$\delta\alpha \times \int_0^{+\infty} \exp(-\rho t) \frac{u'(c_t^N)}{u'(c_0^N)} \Delta_t^\star dt = 0$$

Constrained Inefficiency (for any Pareto weights)

Proposition. (Constrained inefficiency)

Generically, there exists $\{\delta\alpha, \delta T\}$ such that $\delta U^A > 0$ and $\delta U^N = 0$. This requires $\delta\alpha < 0$.

(automated)

$$\delta\alpha \times \int_0^{+\infty} \exp(-\rho t) \frac{u'(c_t^A)}{u'(c_0^A)} \Delta_t^\star dt \stackrel{?}{=} 0$$

(non-automated / firm)

$$\delta\alpha \times \int_0^{+\infty} \exp(-\rho t) \frac{u'(c_t^N)}{u'(c_0^N)} \Delta_t^\star dt = 0$$

1. The output gains from automation $\Delta_t^\star$ **build up** over time

Constrained Inefficiency (for any Pareto weights)

Proposition. (Constrained inefficiency)

Generically, there exists $\{\delta\alpha, \delta T\}$ such that $\delta U^A > 0$ and $\delta U^N = 0$. This requires $\delta\alpha < 0$.

(automated)

$$\delta\alpha \times \int_0^{+\infty} \exp(-\rho t) \frac{u'(c_t^A)}{u'(c_0^A)} \Delta_t^\star dt > 0$$

(non-automated / firm)

$$\delta\alpha \times \int_0^{+\infty} \exp(-\rho t) \frac{u'(c_t^N)}{u'(c_0^N)} \Delta_t^\star dt = 0$$

1. The output gains from automation $\Delta_t^\star$ **build up** over time
2. Automated workers are *more impatient* than the firm — priced by unconst. workers

Constrained Inefficiency (for any Pareto weights)

Proposition. (Constrained inefficiency)

Generically, there exists $\{\delta\alpha, \delta T\}$ such that $\delta U^A > 0$ and $\delta U^N = 0$. This requires $\delta\alpha < 0$.

(automated) (non-automated / firm)

$$\delta\alpha \times \int_0^{+\infty} \exp(-\rho t) \frac{u'(c_t^A)}{u'(c_0^A)} \left(\Delta_t^\star + \Sigma_t^{\star,A}\right) dt > 0 \qquad \delta\alpha \times \int_0^{+\infty} \exp(-\rho t) \frac{u'(c_t^N)}{u'(c_0^N)} \left(\Delta_t^\star + \Sigma_t^{\star,N}\right) dt < 0$$

1. The output gains from automation $\Delta_t^\star$ **build up** over time
2. Automated workers are *more impatient* than the firm — priced by unconst. workers

Constrained Inefficiency (for any Pareto weights)

Proposition. (Constrained inefficiency)

Generically, there exists $\{\delta\alpha, \delta T\}$ such that $\delta U^A > 0$ and $\delta U^N = 0$. This requires $\delta\alpha < 0$.

(automated) (non-automated / firm)

$\delta U^A > 0$ $\delta U^N = 0$

1. The output gains from automation $\Delta_t^\star$ **build up** over time
2. Automated workers are *more impatient* than the firm — priced by unconst. workers
3. Set $\delta\alpha < 0$, and $\delta T < 0$ to compensate non-auto. workers (akin to future transfer)

CONSTRAINED INEFFICIENCY (FOR ANY PARETO WEIGHTS)

Proposition. (Constrained inefficiency)

Generically, there exists $\{\delta\alpha, \delta T\}$ such that $\delta U^A > 0$ and $\delta U^N = 0$. This requires $\delta\alpha < 0$.

(automated) (non-automated / firm)

$\delta U^A > 0$ $\delta U^N = 0$

Taxing automation increases **aggregate consumption** and **redistributes** early on during the transition, precisely when **displaced workers** value it more.

Optimal Policy Intervention

- Optimal intervention depends on how the government values efficiency *vs.* equity.

Optimal Policy Intervention

- Optimal intervention depends on how the government values efficiency *vs.* equity.
- No pref. for equity: The government uses **efficiency weights** $\{\eta^{h,\text{effic}}\}$

  Gov't does not distort an efficient allocation to improve equity (think "inverse marginal utility weights")

- Optimal intervention depends on how the government values efficiency *vs.* equity.
- No pref. for equity: The government uses **efficiency weights** $\{\eta^{h,\text{effic}}\}$

  Gov't does not distort an efficient allocation to improve equity (think "inverse marginal utility weights")
- Optimality condition wrt α

$$\frac{\delta \mathcal{U}}{\delta \alpha} = \sum_h \eta^{h,\text{effic}} u'(c_0^h) \times \int_0^{+\infty} \exp\left(-\rho t\right) \frac{u'(c_t^h)}{u'(c_0^h)} \times \left(\Delta_t^\star + \Sigma^{h,\star}\right) dt = 0$$

Optimal Policy Intervention

- Optimal intervention depends on how the government values efficiency *vs.* equity.
- No pref. for equity: The government uses **efficiency weights** $\{\eta^{h,\text{effic}}\}$
  Gov't does not distort an efficient allocation to improve equity (think "inverse marginal utility weights")
- Optimality condition wrt α. Negative when evaluated at laissez-faire

$$\frac{\delta \mathcal{U}}{\delta \alpha} = \sum_h \eta^{h,\text{effic}} u'(c_0^h) \times \int_0^{+\infty} \underbrace{\exp(-\rho t) \frac{u'(c_t^h)}{u'(c_0^h)}}_{<\exp\left(-\int_0^t r_s ds\right) \text{ for } h=A} \times \underbrace{\left(\Delta_t^\star + \Sigma^{h,\star}\right)}_{\text{Back-loaded}} dt < 0$$

Optimal Policy Intervention

- Optimal intervention depends on how the government values efficiency *vs.* equity.
- **No pref. for equity**: The government uses **efficiency weights** $\{\eta^{h,\text{effic}}\}$

  Gov't does not distort an efficient allocation to improve equity (think "inverse marginal utility weights")
- Optimality condition wrt α. Negative when evaluated at laissez-faire

$$\frac{\delta \mathcal{U}}{\delta \alpha} = \sum_h \eta^{h,\text{effic}} u'(c_0^h) \times \int_0^{+\infty} \underbrace{\exp(-\rho t) \frac{u'(c_t^h)}{u'(c_0^h)}}_{< \exp\left(-\int_0^t r_s ds\right) \text{ for } h=A} \times \underbrace{\left(\Delta_t^\star + \Sigma^{h,\star}\right)}_{\text{Back-loaded}} dt < 0$$

Proposition. (Taxing automation on efficiency grounds)

A government using efficiency weights $\{\eta^{h,\text{effic}}\}$ finds it optimal to tax automation.

- Optimal intervention depends on how the government values efficiency *vs.* equity.
- **No pref. for equity**: The government uses **efficiency weights** $\{\eta^{h,\text{effic}}\}$
  Gov't does not distort an efficient allocation to improve equity (think "inverse marginal utility weights")
- Optimality condition wrt α. Negative when evaluated at laissez-faire

$$\frac{\delta\mathcal{U}}{\delta\alpha} = \sum_h \eta^{h,\text{effic}} u'(c_0^h) \times \int_0^{+\infty} \underbrace{\exp(-\rho t)\frac{u'(c_t^h)}{u'(c_0^h)}}_{<\exp\left(-\int_0^t r_s ds\right) \text{ for } h=A} \times \underbrace{\left(\Delta_t^\star + \Sigma^{h,\star}\right)}_{\text{Back-loaded}} dt < 0$$

Proposition. (Taxing automation on efficiency grounds)

A government using efficiency weights $\{\eta^{h,\text{effic}}\}$ finds it optimal to tax automation.

- **Pref. for equity**: Government taxes even more with utilitarian weights

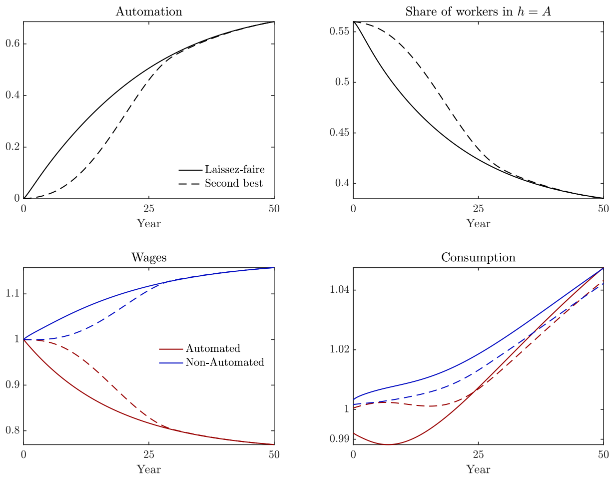
Outline

Quantitative Model

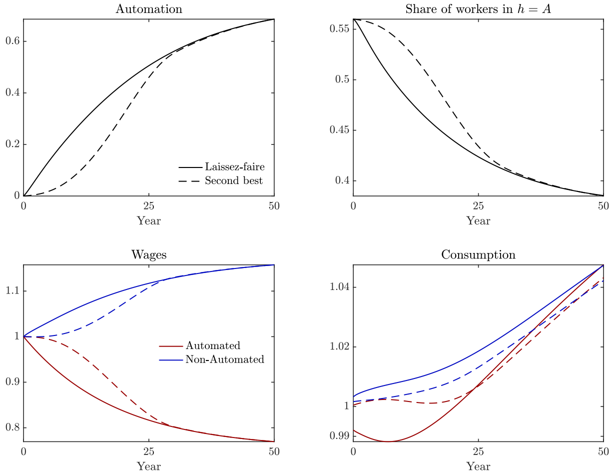
- **Adds**: gradual autom. + idiosync. risk (Huggett-Aiyagari) + gross flows (McFadden)

Quantitative Model

- **Adds**: gradual autom. + idiosync. risk (Huggett-Aiyagari) + gross flows (McFadden)



- **Adds**: gradual autom. + idiosync. risk (Huggett-Aiyagari) + gross flows (McFadden)



Half-life of automation

15 years at LF v. 20 years at SB

Welfare gains

0.8% for A workers and 0.2% overall

The Ugly: the surveillance state

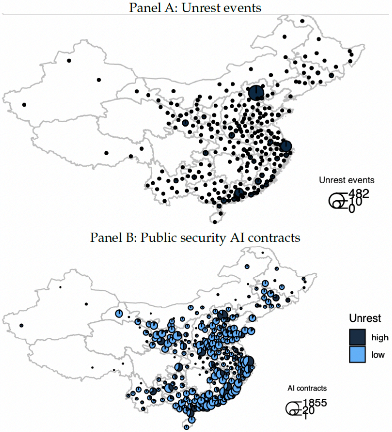
- As a technology of **prediction**, gov'ts may use AI for repression and social control (Zuboff, 2019; Tirole, 2021; Acemoglu, 2021)
- Facial recognition AI, in particular, is a technology of **surveillance** (and dual-use)

The Ugly: the surveillance state

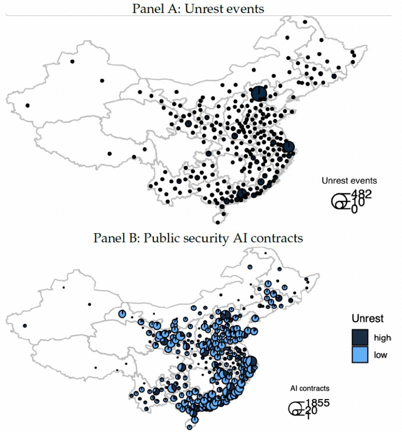
- As a technology of **prediction**, gov'ts may use AI for repression and social control (Zuboff, 2019; Tirole, 2021; Acemoglu, 2021)
- Facial recognition AI, in particular, is a technology of **surveillance** (and dual-use)

Evidence from China?

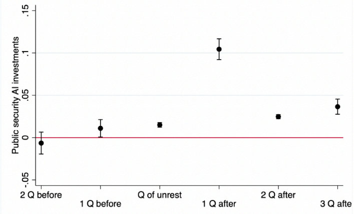
Unrest and gov't procurement of AI

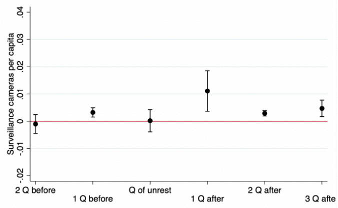


Unrest and gov't procurement of AI



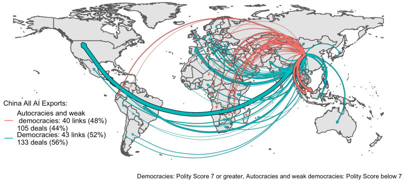
Unrest ⟶ Gov't buys AI and cameras

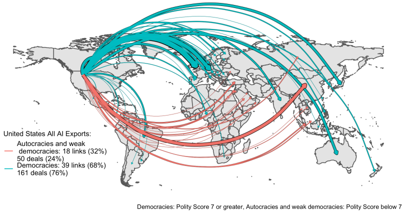




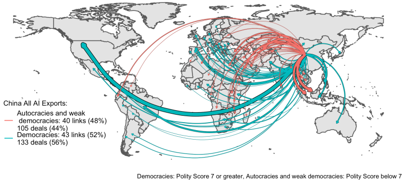
Exporting the Surveillance State via Trade in AI

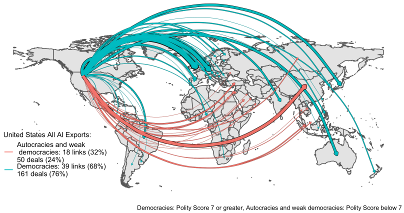
Exports of AI: China v. US



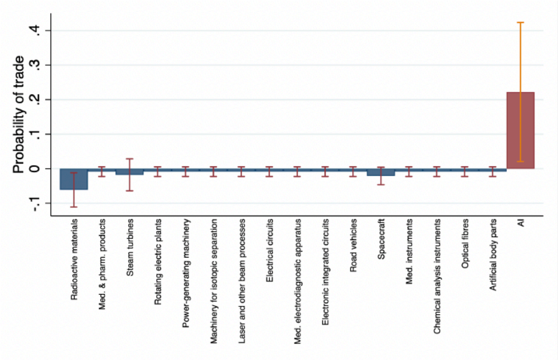


Exports of AI: China v. US





Autocracies and weak democracies are more likely to import AI from China



Final thoughts

- AI is a new technology with many **different features and uses**
- Touches on issues **across fields**: macro (growth, innovation, labor), pol. econ, IO

Final thoughts

- AI is a new technology with many **different features and uses**
- Touches on issues **across fields**: macro (growth, innovation, labor), pol. econ, IO
- Social scientists have a **responsibility** to study the benefits, risks, and policy implications of AI
  - Otherwise, we leave the task to...
- We have only started to scratch the surface. **More questions** as AI is widely adopted.

Much work ahead!